ARLFRD Activities Report
January 2002

Research Programs

New Tracer Detection Technology for Homeland Security

Atmospheric tracers are finding increasing use for threat assessment and dispersion model evaluation in urban environments. Real-time sensors are necessary to assess acute exposure predictions. Unfortunately, FRD's older real-time sensors are large and bulky which limits use. Small sensors, which have greater deployment flexibility, are needed. Ion Mobility Spectrometry (IMS) appears to be the solution.

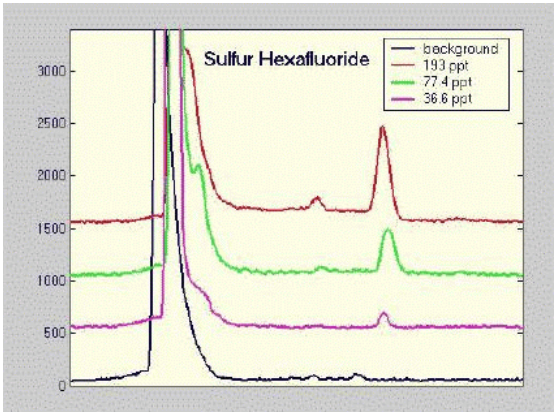

Figure 1. IMS spectra showing SF_6 as rightmost peak.

Working with FRD, Dr. David Atkinson of the INEEL conducted a sulfur hexafluoride (SF_6) sensitivity study on a bench-top IMS. Figure 1 shows the instrument's spectra for three concentrations of SF_6 down to 37 parts per trillion (ppt). The peak for the 37 ppt sample is well above the instrument noise. The limit of detection for our current continuous SF_6 analyzers is 20 to 30 ppt. From these results, IMS systems are capable of matching the performance of our current continuous analyzers. The use of IMS technology represents a significant step forward in developing technology needed to support required homeland defense research. IMS systems offer several potential advantages over other technologies including lower costs, operation without the compressed gases required by our current analyzers, and the potential for a very small instrument allowing deployment in a wide variety of vehicles and locations. For example, Figure 2 shows a commercially available IMS instrument. This is NOT the instrument used to generate the spectra in Figure 1, but an SF_6 instrument could be close to this size. They also have the capability to detect several compounds at the same time, which gives the possibility of adapting them to multiple tracer experiments. We are currently investigating commercially available handheld IMS systems that may be adaptable to SF_6 measurements. (Roger.Carter@noaa.gov, Debbie Lacroix, Shane Beard)


Figure 2. A commercially available hand held IMS system.

Improving Current Tracer Technology for Homeland Security

The evaluation of dispersion models also requires knowledge of total integrated concentration so that doses can be calculated. This requires the use of bag samplers and stationary analyzers. We have been working to upgrade this technology, as well. Three new Automated Trace Gas Analysis Systems (ATGAS) have been completely redesigned and rebuilt. A fourth is being assembled. The new ATGAS demonstrates slightly less than one ppt SF_6 detection limit based on 20 replicates when the calibration was 1.97 ppt to 5060 ppt. The results met acceptable preset quality control limits for relative standard deviation (RSD), signal to noise and recovery.

Figure 3 shows the old version of the ATGAS, including the separate computer, autosampler, GC oven and various instruments for voltage, temperature and flow readouts. Figure 4 shows the new version of the ATGAS, which includes the same components as the old version except that they are all enclosed within one instrument.

Figure 3. Old ATGAS

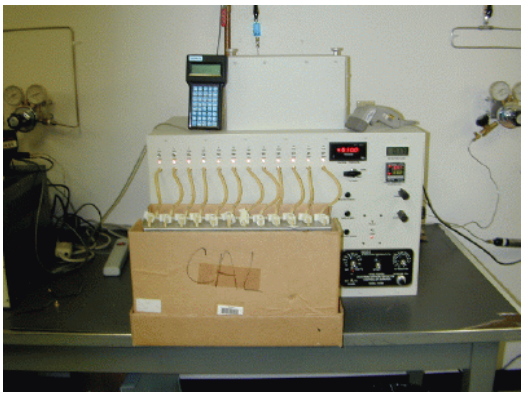

Figure 4. New ATGAS

The new ATGAS's were built to run more efficiently and quietly. Because they are also compact and lighter, they will be easy to ship and use in the field. The following hardware advantages were built into the new system:

- Weight is significantly less: 65 vs. 190 lbs.
- System components are all contained in one single instrument housing.
- Selection of which bags to be analyzed is controlled by toggle switches.
- Fewer valves: 1 vs. 3.
- Greatly reduced sample purge time: 3 times in 30 sec. vs. 130 sec.
- Smaller footprint: 5 sq. ft. vs. 16 sq. ft.
- Fewer computers: 1 vs. 7.
- Greatly reduced noise level.
- Greatly reduced tubing in the system to reduce chances of leaks.
- Fewer actuators: 1 vs. 3.
- Fewer uninterruptible power supplies (UPS): 1 vs. 4.
- The columns and sample loop are easily reached with minimal effort.

The software for the new ATGAS's was also updated to provide the analysts an easy-to-use system that is flexible, accessible and accurate. Training requirements to use the software will be minimal due to this ease of use. The following software enhancements were incorporated:

1. The software is Microsoft® Windows based. Therefore, the condition of each ATGAS can be constantly monitored in their corresponding window while several icons are available to execute a number of other monitoring software functions.
2. Within each window, the concentration of the last twelve results and any associated data flags will be shown along with the sample being analyzed. If the sample being analyzed is a calibration verification check, the recovery will also be shown to give the analyst instant feedback as to the validity of the curve being used.
3. Printouts of all chromatograms, summary sheets, and quality control sheets for quick data verification can easily be done at the end of each analysis day. All data will be validated by a second person familiar with the analysis and QC requirements. Verified data will be immediately available for review in the database.
4. There are quality control error messages to let the analyst know if the calibration is unacceptable, or if the ATGAS is due for calibration verification. These are very helpful when analyses are extended for extremely long periods. Other error checks can be easily incorporated if the need arises.
5. Icons can quickly show the history of each cartridge, and can be selected to generate and view project results, and to print an analysis summary to make sure all bags have been analyzed and that a reliable value has been generated, if such is possible.
6. Old data can be easily reviewed, even while the ATGAS's are running. These data can be very easily retrieved and printed if desired.
7. Data flags are automatically set according to preset quality control conditions. These flags can easily be modified by the analyst if needed.

The creation of the new ATGAS's also helped to alleviate safety issues related to old equipment such as the occurrence on August 27, 2001, when the temperature of one of the old ovens ramped up, melted the thermocouples, seized the 10 port valve ($400 item), clogged the tubing with what appears to be a ceramic material, plugged the columns (~$400 items), plugged the purifier tube ($112), blew out the resistors on the data acquisition board ($3000 item) and probably contaminated the detector ($1900 item to refurbish). These items will need to be either repaired or replaced for use in the new ATGAS's. It was very lucky that a fire did not occur due to the extremely high temperature within the oven. The new ATGAS's have been designed so that such a high temperature ramp cannot occur. (Debbie.Lacroix@noaa.inel.gov, Roger Carter, and Shane Beard)

CBLAST-Low

Analysis has begun on the CBLAST-Low pilot field study data. The LongEZ research aircraft, flying over the waters south of Martha's Vineyard, acquired a total of 48 profiles of the vertical structure of the marine atmospheric boundary layer (MABL) at various locations offshore. In most cases, the lowest levels of the MABL were very stable. However, the structure of the MABL is anything but simple.

Figure 5 shows an example sounding acquired by the LongEZ on August 8, 2001 in the early morning (~ 0830 local time) just north of the Woods Hole Oceanographic Institution Air-Sea Interaction Meteorology buoy. The weather was hazy, very hot, and humid in Martha's Vineyard with very light northwesterly winds observed at the airport ahead of a stalled cold front. The 10-m surface winds are light (~ 3 m s^{-1}) from the west. However, a pronounced 7 m s^{-1} jet from the west-northwest is found a mere 50 m above the ocean surface. The air temperature profile shows a very strong inversion of 5° C over that vertical distance of 50 m. The relative humidity in this layer quickly decreases from saturation to about 80 per cent.

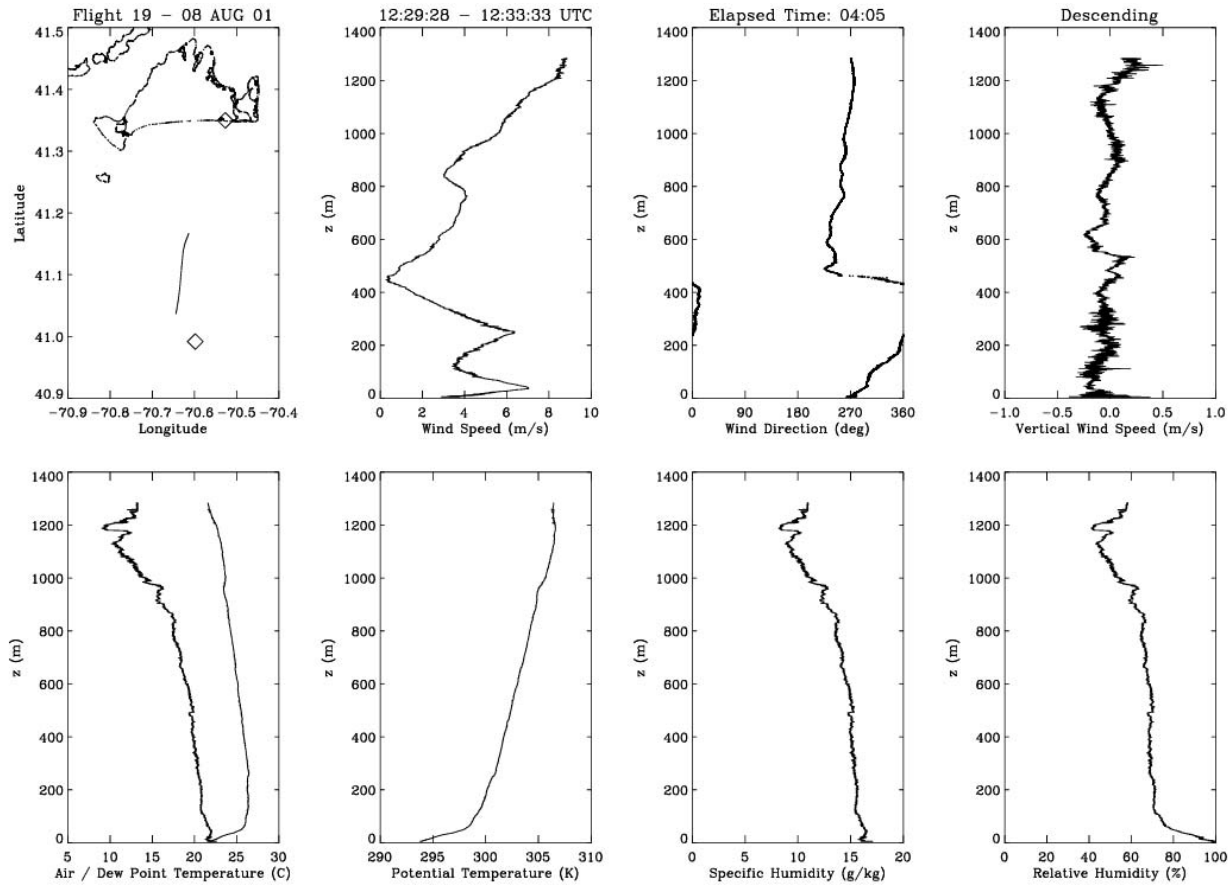

Figure 5. Example MABL profiles of wind, temperature, and humidity acquired by the LongEZ during the CBLAST-Low pilot field study.

The winds continue to veer to the northwest with height from 50 to 100 m; however, the wind speed decreases to slightly less than 4 m s^{-1}. The air temperature and humidity are nearly isothermal in this overriding layer. The winds continue to veer with height to the north from 100 to 250 m with wind speeds once again increasing to a maximum jet of 6 m s^{-1}. Potential temperature profile still shows a very stable layer while humidity decreases very slowly with height.

From 250 to 450 m, the winds abruptly back from the north to southwest with winds steadily decreasing from 6 to less than 1 m s^{-1}. While the air temperature and specific humidity slowly decrease with height, the relative humidity is fairly constant. From 450 to 1300 m, the wind speed increases linearly with height from near calm to 9 m s^{-1} while the wind direction veers slightly from southwesterly to westerly. The specific humidity falls to a minimum of 10 g kg^{-1}.

The moist, southwesterly synoptic-scale flow of the Bermuda High is apparent above 450 m. Meanwhile, the offshore flow in the lowest 200 m of the MABL resembles a land breeze flow moving off the slightly cooler land mass over the warmer waters. A common feature seen in other LongEZ profiles under very stable conditions is the low-level jet found near the top of these strong surface-based inversions. (Jerry.Crescenti@noaa.gov)

Important progress has been achieved on the development of an algorithm which defines highly accurate flight-altitude by blending laser-array and GPS altitude data. The laser array is more accurate at low altitudes than GPS at higher altitudes. In the past, only the GPS was used for altitude reference. However, for low-altitude flux runs, flight altitude is an important parameter. (tami@noaa.inel.gov)

URBAN 2000/VTMX/URBAN 2003

Work continues on our urban homeland security effort. A statement of work is being developed for completion of URBAN 2002 data analysis and to prepare for the upcoming URBAN 2003 project. A reconnaissance trip is being planned for 26-28 February to Oklahoma City to determine sampler locations, etc. The area will also be surveyed for sources of fugitive SF_6. (Kirk.Clawson@noaa.gov)

Hurricane Balloon

Presently there is significant resistance within the ranks of NOAA AOC and the 53rd Weather Reconnaissance Squadron (53rd WRS) to fly in a hurricane with an unproven platform such as the Hurricane Balloon. This is especially true since we are going to be unable to meet or even come close to the 20 meter per second descent rate necessary to ensure that we can bring the balloon down in a hurricane with significant updraft conditions. From test data, it looks as though 3 to 5 meters per second balloon descent rates are about as fast as we can expect due to of the shape of the balloon as it deflates.

Early in January, we had hopes that we could get a very significant decrease in descent rate requirements from AOC and the 53rd WRS that would allow us to fly in a storm with their flights this hurricane season. This was discussed with Phil Kenul at AOC, John Gaynor at NOAA (USWRP), and Frank Marks at NOAA HRD. Frank Marks suggested that we prove the operation, controllability, and research value of the data gathered by the hurricane balloon before we ask AOC and the 53rd to fly in a hurricane with it.

Considering these constraints, the most promising and easiest logistical option discussed (other than the eastern USA) was to launch the balloon from the west coast of southern Mexico. Frank suggested that Dave Raymond could be very valuable in helping us determine the feasibility of getting permission to do this and help us with some of the difficulties we may encounter. (Randy.Johnson@noaa.gov)

Cooperative Research with INEEL

INEEL Support

The University of Oregon requested a data set from the Aberdeen tower of the INEEL Mesoscale Meteorological Network. They had previously been retrieving data from the Bureau of Reclamation, which includes data from that tower in their AgriMet data set. However, the Department of Interior was ordered by a federal court to disconnect all their computers from the internet which has made that data set unavailable. We will continue to fill these requests until the Department of Interior is back on line. (Roger.Carter@noaa.gov, Neil Hukari)

Each year FRD provides INEEL with joint frequency distributions of the winds at specific Mesonet towers. In January, joint frequency distributions based on calendar-year 2001 data were computed and provided to INEEL. These distributions bin the wind observations according to wind-speed, wind direction, and Pasquill-Gifford stability class. The distributions are used by INEEL as part of their annual environmental assessments. (Richard.Eckman@noaa.gov)

In late 2001, INEEL requested that FRD perform a multi-year study of diffusion at the site using the MDIFF model. The basic idea is to run a long sequence of consecutive pollutant releases using several years of archived Mesonet data to drive MDIFF. Upon completion, one will have an ensemble of total integrated concentrations (TIC) at each grid (or receptor) point in the model domain. Statistics (*e.g.*, medians, 95th percentiles) can then be generated from the ensembles. INEEL uses these statistics in hazard assessments. Although FRD has operated a Mesonet at INEEL for decades, the current incarnation has been in operation since 1993. Hence, the multi-year diffusion study will be based on data from 1993-2001. January was spent in organizing the archived Mesonet data and in modifying the MDIFF model so that it can generate the TIC ensembles at each grid point. (Richard.Eckman@noaa.gov)

INEEL Mesoscale Modeling

FRD's Alpha workstation used for MM5 simulations was brought back online in mid January after suffering another major malfunction in December. The video card was replaced, but it was then discovered that both PS/2 ports (mouse and keyboard) had also failed. These ports are soldered to the motherboard, so there is no easy way to replace them. The only remaining way to physically interface with the workstation is by connecting another computer to the workstation's serial port. Once the Unix operating system is up and running, the workstation can be accessed normally through the local network. There is some suspicion that the Alpha workstation's problems may partly be due to electrical wiring problems at FRD. (Richard.Eckman@noaa.gov)

Once the Alpha workstation was online, improvements were made to the MM5 forecast products that are displayed on FRD's web page http://www.noaa.inel.gov/personnel/Eckman/MM5/. Hourly forecast time series are now available on this web page for both Idaho Falls and INEEL. Separate time series are provided for the northern and southern ends of INEEL, because it is known from tower measurements that the meteorological conditions at the northern end of the site are often quite different from the southern end. Preliminary evaluations are now underway to determine the skill of the MM5 forecasts using observations from FRD's tower network. (Richard.Eckman@noaa.gov, Neil Hukari)

Other Activities

Safety

Three draft policies were peered reviewed for NOAA's Environmental Compliance and Safety Council (ECS). The draft policies included, "Draft 2 Proposed Protocol for Interactions Between NOAA Facilities and Environmental and Occupational Safety and Health Regulatory Agencies", "Standardized Language Minimizing Environmental Liability in Purchase and Lease Agreements, Contracts and Statements of Work", and "NOAA Waste Disposal Policy". (Debbie@noaa.inel.gov)

A meeting was held with Kevin Hungate, a DOE safety training representative, to discuss the possibility of contracting with them to provide required training to FRD personnel. He was presented with a list of training needs and will respond with an estimate of the cost for each training session. We should be able to use many of their resources such as video, web-based and in-house training. Much of the training can be done for free or at a nominal charge. He is also checking on the cost of contracting with their ergonomics specialist to provide review of FRD workstations. (Debbie@noaa.inel.gov)

ARMS Review

Representatives from the Interagency Committee on Aviation Policy (ICAP) visited FRD on January 30 and 31 to conduct an Aviation Resource Management Survey (ARMS) and safety review. The focus was on the use of the LongEZ aircraft in ARL research programs. The review was requested by Rear Admiral Evelyn Fields. The review committee will publish their findings within a few weeks. (Tim.Crawford@noaa.gov)

NAERS Workshop

FRD staff hosted the First International Workshop of the new organization *Network of Airborne Environmental Research Scientists (NAERS)*. This international network of scientists will cooperate in the use of Small Environmental Research Aircraft (SERA), airborne instrumentation, and airborne data to investigate and solve various environmental problems.

Dr. Paul Shepson from Purdue University shares his vision of SERAs as future air chemistry vehicles at the NAERS Workshop.

The twenty-seven charter member scientists represent the operation of seven different SERAs and two lighter-than-air platforms in seven countries. Within the next few weeks, the NAERS web page and list server will become operational. Considering the high enthusiasm at the first meeting, we expect this organization to rapidly grow.

NAERS workshop group photo.

The NAERS first workshop and membership meeting took place January 28-29, 2002 in Idaho Falls, Idaho. During the two-day workshop, six sessions focused on improving the safety and effectiveness of airborne research efforts and the utility of the resulting science. The agenda with an attendance list can be viewed at http://www.noaa.inel.gov/docs/workshop.pdf The membership proposed that the next meeting take place April, 2003, in Italy. A synopsis of the meeting will be written and submitted to the *Bulletin of the American Meteorological Society*. (Tim.Crawford@noaa.gov, Jerry Crescenti, and Jeff French)

Papers

Crescenti, G. H., J. R. French, T. L. Crawford, and D. C. Vandemark, 2002: An integrated airborne measurement system for the determination of atmospheric turbulence and ocean surface wave field properties. Preprint, *Sixth Symposium on Integrated Observing Systems*, Orlando, FL, Jan. 13-17, Amer. Meteor. Soc., 60-67.

Papers Reviewed

Isaac, P. R., J. McAneney, R. Leuning, and J. M. Hacking, 2002: Comparison of aircraft and ground based flux measurements during OASIS95. Reviewed for *Bound.-Layer Meteor.*

Travel

Tom Watson to Silver Spring, Maryland, January 8-22, 2002 to participate in instrument preparation for the upcoming Bay Region Atmospheric Chemistry Experiment (BRACE).

Jerry Crescenti, Kirk Clawson, and Tim Crawford attended the 82nd Annual Meeting of the American Meteorological Society in Orlando, Florida from January 13-17, 2002.

Kirk Clawson attended the Annual DOE Meteorological Coordinating Council (DMCC) meeting in Orlando, FL, January 14, 2002 and presented FRD's current state of affairs with regard to the INEEL meteorological program.

Training

Jerry Crescenti attended and participated in a Communications Workshop sponsored by the American Meteorological Society in Orlando, Florida on January 13, 2002. A portion of the workshop involved a panel discussion moderated by Jim Hartz, former host of NBC's *Today Show*. Panelists included Rick Chappell (Vanderbilt University), Max Mayfield (Director of NOAA's National Hurricane Center), Peter Spotts (Science and Technology Correspondent for *The Christian Science Monitor*), Sid Perkins (Earth Science Writer for *Science News*), and Jeff Gafney (Research Chemist for Argonne National Laboratory). This workshop stressed effective communications between the scientific community and the media.

Kirk Clawson attended a one-day training seminar "Communicating with Tact and Finesse for Managers and Supervisors" in Idaho Falls, ID on January 29, 2002.

Visitors

Dr. Carmen Nappo from ARL/ATDD in Oak Ridge, Tennessee visited FRD on 14-15 January to discuss future research related to the CASES-99 program. He also held discussions with FRD staff on the possibility of studying gravity-wave generated turbulence using the Long-EZ aircraft.

Rick Artz, Deputy Director of the Air Resources Laboratory visited from January 29-31, 2002 to participate in the NAERS workshop and ICAP ARMS safety review.

Dr. Kenji Yazawa from the Flight System Research Center of Japan's National Aerospace Laboratory of Japan visited FRD on January 31, 2002 to discuss airborne wind measurement instrument systems.

Dr. Walter C. Oechel, Rommel C. Zulueta, and Joe Verfaillie from the Global Change Research Group of the San Diego State University visited on January 30-31, 2002 to discuss calibration, software and instrumentation for their Sky Arrow aircraft.

Awards

Kirk Clawson received NASA's "Turning Goals into Reality" award for "outstanding contributions to [the] Aircraft Vortex Spacing System (AVOSS) Team; Revolutionizing aviation by increasing capacity while maintaining a high degree of safety."